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Support for ACS COLL Division Symposium on: Patchy Particles and Surfaces of Engineered Heterogeneity: Synthesis to Dynamic Function

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The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT
This grant provided travel support for invited speakers to facilitate a symposium on “Patchy Surfaces and Interfaces” within the Colloid and Surface Chemistry Division of the American Chemical Society (ACS), at the 238th National ACS Meeting in August 2009 in Washington DC. The grant also provided support for a website to disseminate technical information to those unable to attend the symposium. This ARO grant provided partial support for eleven invited speakers, two of them from overseas. The symposium took place for 2 full days, on

15. SUBJECT TERMS
Conference, Speaker Support, Patchy Interfaces

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a. REPORT	b. ABSTRACT	c. THIS PAGE			Maria Santore
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Report Title

Support for ACS COLL Division Symposium on: Patchy Particles and Surfaces of Engineered Heterogeneity: Synthesis to Dynamic Function

ABSTRACT

This grant provided travel support for invited speakers to facilitate a symposium on "Patchy Surfaces and Interfaces" within the Colloid and Surface Chemistry Division of the American Chemical Society (ACS), at the 238th National ACS Meeting in August 2009 in Washington DC. The grant also provided support for a website to disseminate technical information to those unable to attend the symposium. This ARO grant provided partial support for eleven invited speakers, two of them from overseas. The symposium took place for 2 full days, on August 19 and 20 in the Ronald Regan building. The talks were extremely well attended, with roughly 200 people in the audience. Subject matter ranged from methods for preparing and characterizing patchy surfaces and particles (with patchy lengthscales from 10 nm up to about half a micron), to investigations of the unique properties of deriving from interfacial patchiness. The latter include bioadhesive and bioresponsive behaviors of cells and bacteria, selective adhesive behavior of cells and particles without biomolecular fragments, assembly of new materials with magnetic, optical, and photonic properties, self-replicating colloidal structures, and sensors.

List of papers submitted or published that acknowledge ARO support during this reporting period. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Number of Papers published in peer-reviewed journals: 0.00

(b) Papers published in non-peer-reviewed journals or in conference proceedings (N/A for none)

Number of Papers published in non peer-reviewed journals: 0.00

(c) Presentations

Here is a list of all the invited speakers, whose attendance was made possible, in part, by this grant.

- N.J. Halas, "Symmetry-Breaking Plasmonic Nanostructures: New Properties Driving New Synthetic Opportunities" This talk explored optical properties of assemblies of structured colloids.

- I. Kretzschmar "Patchy Particles" This talk detailed methods to create patchy particles and examined their assembly behavior.

J. C. Garno "High-Throughput Nanoscale Patterning using Particle Lithography: Characterizations Using Atomic Force Microscopy" This talk explored means to nano-pattern large areas of surface with a variety of materials through very economic means.

D. Velegol and H.A. Jerri, "Fabrication of Anisotropic Focus-Released Microcapsules" This talk explored the creation of patchy hydrogel particles and their use in targeted release applications.

T.A. Camesano "Role of LPS Heterogeneity on Adhesio of Gram-Negative Bacteria" This talk explored how heterogeneities on the surface of bacteria controlled bacterial adhesion and correlated with virulence.

D.J. Pine "Structured Colloids: Patches, Packmen, and Helices" This talk demonstrated the creation of a variety of patterned particles that either assembled in a self-replicating fashion or demonstrated lock and key selective binding, the latter without the use of biomolecular fragments.

E. Luijten "Assembly Behavior of Janus Particles and the Role of Hydrodynamic Interactions" This talk explored the influence of hydrodynamic coupling on the assembly of janus-type patterned particles.

J.P. Spatz "Nanopattern Surfaces for Molecular Engineering of Cellular Environments" This talk explored the interactions of cells with nanopatterned surfaces. Among the interesting findings was a sharp 60 nm threshold in feature spacing, below which cells adhered, and above which materials were significantly less adhesive towards the cells.

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Z. Adamczyk "Deposition of Particles at Heterogeneous and Patterned Surfaces" This presentation explored experimental studies of particle deposition on patchy surfaces focusing on dynamic and structural aspects of the interfaces.

M. Santore "Using Patchy Surfaces for Selective Particle and Cell Adhesion and Dynamic Motion Control" This talk demonstrated biomimetic features of particle adhesion on nano-patchy surfaces: sharply selective particle binding without use of biomolecular fragments, and control of adhesion dynamics and signature, including particle rolling for separations and sensing.

Number of Presentations: 11.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

(d) Manuscripts

Number of Manuscripts: 0.00

Number of Inventions:

Graduate Students

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Post Doctorates

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Faculty Supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	0.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:.....	0.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:.....	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):	0.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:	0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME PERCENT_SUPPORTED

FTE Equivalent:

Total Number:

Sub Contractors (DD882)

Inventions (DD882)

This grant facilitated a symposium on patchy interfaces (particles and surfaces) at the 238th National ACS Meeting in Washington DC. The symposium itself was held on August 19th and 20th, 2009.

The symposium brought together scientists from diverse fields beyond the colloid community, including experts on optical and photonic materials, numerical simulation, multiphase fluid flows, biomaterials, bacteriology, tribology, pharmaceuticals, and adhesion science.

Beyond new methods to create interfaces and particles with controlled nanoscale surface features, the symposium highlighted the unusual and highly tunable range of properties and behaviors that result from engineered surface patchiness or hetergeneity. General themes within the symposium included:

- **Production of patchy particles and surfaces**. Particle lithography (single particle or crystalline masks), nanosphere lithography, glancing angle deposition, controlled colloidal deposition and templating, and other techniques to create patchy surfaces and particles of controlled character, giving them "bond regions" and other functionalities.
- **Characterization of patchy interfaces**. FESEM, TEM, confocal, colloidal force AFM, and other microscopies for direct characterization of heterogeneous interfaces. A goal is to relate the information from these new methods to more classical interfacial metrics such as zeta potential and colloidal stability / adhesion. Other techniques were also included, especially those that allow examination of responsive functions like dynamic assembly (i.e., assemblies that change shape or configuration following on a stimulus).
- **Assembly and organization**. Patchy interfaces possess the unique ability to direct assembly in highly selective ways, leading to new organized colloidal materials, some of which are important to the development of novel energy sources, sensors, and electro optics.
- **Unique dynamic behaviors**. From highly specific binding and unusual dynamic signatures (the ability to control rolling and slipping, or the mimic of catch-stick versus catch-slip bonds), to tunable hydrodynamic responsiveness, the adhesive junctions between patchy interfaces and other materials exhibit precisely engineered capability. These fundamental dynamic responses will be the basis for the controlled evolution of assembled structures, and new materials whose dynamic response lies at the heart of their function, for instance biosensors and bioactuators.
- **Modeling of patchy particle assembly**. Monte Carlo and Brownian dynamics simulations used to determine final structures based on the initial patchy particles, plus assembly times.
- **Applications**. Hunters, scavengers, sensors, motors, assembled materials, bacterial adhesion, and other applications. Interactions of patchy structures with light, or with biomolecules and bacteria.

For the purpose of technology transfer to the community beyond the ACS meeting attendees, this grant facilitated a website which summarizes the highlights from the invited talks. That website is now complete: http://www.pse.umass.edu/msantore/PatchyParticlesWebsite.htm

Relevance. The meeting was relevant to several points within the Army's research mission, articulated in sections 6. Physics, 7. Chemistry, 8. Life Sciences, and 9. Materials Science of BAA W911NF-07-R-0003-02.

The idea of colloids and nanoparticles as molecules addresses questions raised in the Condensed Matter Physics area entitled, "Nanoscale physics" (page 46). Assembly of templated particles can be used to make composite particles of unusual shapes which may be expected to display rescaled versions of the behavior of molecular analogs. Separately, within the Chemistry Thrust of this BAA, in the Surfaces and Catalysis section, the Army expresses interest in the interface between nanostructures and biomolecules and biocolloids. The symposium contained a section on the dynamic interaction of the patchy structures and surfaces in the context of biosensors, and targeted fundamental presentations on biomimetic aspects of these patchy interfaces and the interactions of patchy surfaces with biomolecules, bacteria, and cells through invited and contributed talks. As and example of the former, Dr. Professor Joachim Spatz presented his work of biomolecules and cellular interactions with surfaces with extremely fine colloidal-templated structures. Relevant to the BioEngineering topic within the Life Sciences section of the BAA, the proposed symposium included a focus on the biomimetic aspects of patchy interfaces: As the surfaces of living cells is thought to contain heterogeneities arising from protein and phospholipid rafts, there is strong resemblance between biological surfaces and the engineered patchy interfaces. This was borne out in the presentation of Camesano on bacterial adhesion. Further, this aspect of research is being explored in the lab of one of the organizers (Santore), who is finding how these new materials mimic the selective adhesive behaviors of cells. At the meeting Pine's work on lock-and key colloidal recognition and self-replicating colloidal structures further developed ideas of biomimicry deriving from interfacial patchiness. A portion of the proposed symposium to served as a forum for investigators with similar interests. Finally the proposed symposium had strong relevance to nearly all of the Army's interests in Materials Science from materials design and mechanical behavior to synthesis and processing. Patchy colloidal particles and surfaces comprise a new means for materials processing and assembly and are expected to produce assemblies with unique and tunable properties.

Here is a list of all the invited speakers, whose attendance was made possible, in part, by this grant.

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Other information requested:

The following information requested in progress reports of work supported by ARO does not apply to this grant, since the purpose of this grant was to support a symposium rather than scientific research. We there have none of the following to report, but list them here for completeness:

1. No Publications of any kind (papers, manuscripts, books, honors / awards, patents). The meeting talks supported are listed explicitly above.

2. No Personnel (Graduate Students, Faculty, Post Docs, Undergraduates)

3. No Technology transfer to practice (patents, new start up company, interactions with government labs)

4. No Scientific Progress Accomplishments (theory or experiment).

5. No Technical Reports.